

Environmental Protection Agency

§ 1065.644

Using Eq. 1065.640-6,
 $C_f = 0.274$

Using Eq. 1065.640-5,
 $C_d = 0.990$

$$\dot{n} = 0.990 \cdot 0.274 \cdot \frac{0.01824 \cdot 99132}{\sqrt{1 \cdot 0.0287805 \cdot 8.314472 \cdot 298.15}}$$

$\dot{n} = 58.173 \text{ mol/s}$

(c) *CFV molar flow rate.* Some CFV flow meters consist of a single venturi and some consist of multiple venturis, where different combinations of venturis are used to meter different flow rates. If you use multiple venturis and you calibrated each venturi independently to determine a separate discharge coefficient, C_d , for each venturi, calculate the individual molar flow rates through each venturi and sum all their flow rates to determine \dot{n} . If you use multiple venturis and you calibrated each combination of venturis,

calculate \dot{n} as using the sum of the active venturi throat areas as A_t , the square root of the sum of the squares of the active venturi throat diameters as d_t , and the ratio of the venturi throat to inlet diameters as the ratio of the square root of the sum of the active venturi throat diameters, d_t , to the diameter of the common entrance to all of the venturis, D . To calculate the molar flow rate through one venturi or one combination of venturis, use its respective mean C_d and other constants you determined according to §1065.640 and calculate its molar flow rate \dot{n} during an emission test, as follows:

$$\dot{n} = C_d \cdot C_f \cdot \frac{A_t \cdot P_{in}}{\sqrt{Z \cdot M_{mix} \cdot R \cdot T_{in}}} \quad \text{Eq. 1065.642-4}$$

Example:

$C_d = 0.985$

$C_f = 0.7219$

$A_t = 0.00456 \text{ m}^2$

$P_{in} = 98836 \text{ Pa}$

$Z = 1$

$M_{mix} = 28.7805 \text{ g/mol} = 0.0287805 \text{ kg/mol}$

$R = 8.314472 \text{ J/(mol}\cdot\text{K)}$

$T_{in} = 378.15 \text{ K}$

$$\dot{n} = 0.985 \cdot 0.7219 \cdot \frac{0.00456 \cdot 98836}{\sqrt{1 \cdot 0.0287805 \cdot 8.314472 \cdot 378.15}}$$

$\dot{n} = 33.690 \text{ mol/s}$

[75 FR 23047, Apr. 30, 2010, as amended at 75 FR 68464, Nov. 8, 2010; 76 FR 57456, Sept. 15, 2011]

§ 1065.644 Vacuum-decay leak rate.

This section describes how to calculate the leak rate of a vacuum-decay leak verification, which is described in §1065.345(e). Use Eq. 1065.644-1 to calculate the leak rate, \dot{n}_{leak} , and compare

it to the criterion specified in §1065.345(e).

$$\dot{n}_{leak} = \frac{V_{vac}}{R} \cdot \frac{\left(\frac{P_2}{T_2} - \frac{P_1}{T_1} \right)}{(t_2 - t_1)} \quad \text{Eq. 1065.644-1}$$

Where:

V_{vac} = geometric volume of the vacuum-side of the sampling system.

R = molar gas constant.

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p_2 = Vacuum-side absolute pressure at time t_2 .

T_2 = Vacuum-side absolute temperature at time t_2 .

p_1 = Vacuum-side absolute pressure at time t_1 .

T_1 = Vacuum-side absolute temperature at time t_1 .

t_2 = time at completion of vacuum-decay leak verification test.

t_1 = time at start of vacuum-decay leak verification test.

Example:

$V_{\text{vac}} = 2.0000 \text{ L} = 0.00200 \text{ m}^3$

$R = 8.314472 \text{ J}/(\text{mol} \cdot \text{K})$

$p_2 = 50.600 \text{ kPa} = 50600 \text{ Pa}$

$T_2 = 293.15 \text{ K}$

$p_1 = 25.300 \text{ kPa} = 25300 \text{ Pa}$

$T_1 = 293.15 \text{ K}$

$t_2 = 10:57:35 \text{ AM}$

$t_1 = 10:56:25 \text{ AM}$

$$\dot{n}_{\text{leak}} = \frac{0.0002}{8.314472} \cdot \frac{\left(\frac{50600}{293.15} - \frac{25300}{293.15} \right)}{(10:57:35 - 10:56:25)}$$

$$\dot{n}_{\text{leak}} = \frac{0.00200}{8.314472} \cdot \frac{86.304}{70}$$

$$\dot{n}_{\text{leak}} = 0.00030 \text{ mol/s}$$

[73 FR 37327, June 30, 2008]

§ 1065.645 **Amount of water in an ideal gas.**

This section describes how to determine the amount of water in an ideal gas, which you need for various performance verifications and emission calculations. Use the equation for the vapor pressure of water in paragraph (a) of this section or another appropriate equation and, depending on whether you measure dewpoint or relative humidity, perform one of the calculations in paragraph (b) or (c) of this section. The equations for the vapor pressure of water as presented in this section are derived from equations in “Saturation Pressure of Water on the New Kelvin Temperature Scale” (Goff, J.A., Transactions American Society of Heating and Air-Conditioning Engi-

neers, Vol. 63, No. 1607, pages 347–354). Note that the equations were originally published to derive vapor pressure in units of atmospheres and have been modified to derive results in units of kPa by converting the last term in each equation.

(a) *Vapor pressure of water.* Calculate the vapor pressure of water for a given saturation temperature condition, T_{sat} , as follows, or use good engineering judgment to use a different relationship of the vapor pressure of water to a given saturation temperature condition:

(1) For humidity measurements made at ambient temperatures from (0 to 100) °C, or for humidity measurements made over super-cooled water at ambient temperatures from (–50 to 0) °C, use the following equation: